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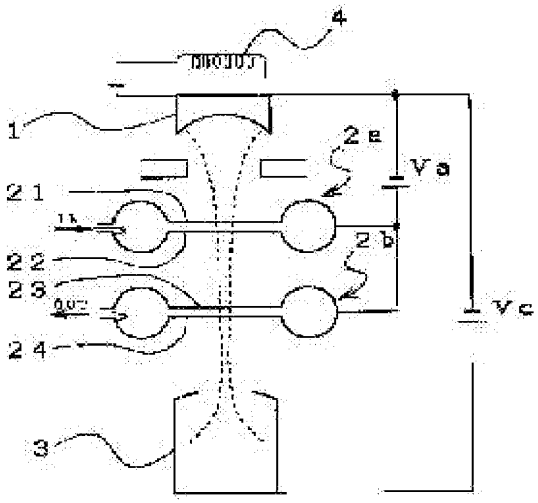
(54) **ELECTRON TUBE**

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an electron tube such as klystron, X-ray tube and the like which have high efficiency.

SOLUTION: In this electron tube that enables an electron beam produced between a cathode and an anode to have a collector electrode for capturing electrons that pass through the anode, the anode is formed thin to the extent that electrons can be transmitted there through.



CLAIMS

[Claim(s)]
[Claim 1]The negative pole.
The anode which an electron taken out from this negative pole passes.
A collector electrode which catches an electron which passed this anode.
It is the electron tube provided with the above, and in said electron, comes to form said anode thinly so that a penetration is possible.

[Claim 2]The electron tube according to claim 1 making potential of said collector electrode into a value lower than said anode.
[Claim 3]The electron tube according to claim 2 when it serves as a target and said electron beam collides said anode with this anode, wherein X-rays generate.
[Claim 4]The electron tube according to claim 3, wherein thickness of said anode and accelerating voltage of an electron impressed to this anode are set as a value from which kinetic energy of an electron which penetrated said anode is set to 10 or more keV.
[Claim 5]The electron tube according to claim 3 or 4 which said anode has multilayer structure and is characterized by a surface's being a metal layer which contributes to generating of X-rays, and at least one layer being other metal layers with a high mechanical strength whose density is lower than said metal layer at least.
[Claim 6]The electron tube according to claim 3 or 4 which carries out two or more step multiple connection of said collector electrode and in which a collector electrode of all the stages except a collector electrode of a final stage is characterized by forming said electron thinly so that a penetration is possible at least.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to what has improved especially the energy utilization efficiency of an electron beam about the electron tube which has a collector electrode which catches the negative pole, the anode which passes an electron, and its electron.
[0002]
[Description of the Prior Art]Conventionally, this kind of electron tube maintains the inside of a bulb at the state near what is called a vacuum with a small degree of vacuum, it accelerates with the voltage which impressed the electron taken out from the negative pole to the anode, and it forms an electron beam, exploits that kinetic energy, and is giving the predetermined function.
[0003]For example, in the case of a klystron, the electron beam passes an input cavity resonator and an output hollow resonator, and is caught by a collector electrode. While reaching a collector electrode from the negative pole, this electron beam can apply density modulation according to the frequency of the microwave inputted into the input cavity resonator, and when it passes an output hollow resonator, it induces microwave to an output hollow resonator. Thus, the klystron operates as the amplifier tube of microwave.
[0004]On the other hand, although it is the same electron tube, it does not have the above structures and there is an X-ray tube. Although an X-ray tube is a vacuum tube of structure which makes an electron beam collide with the anode target which rotated [fixed], and emits X-rays, the actual condition is that the maximum of the kinetic energy which an electron beam has is also convertible for the energy of X-rays only about 1%. Then, the X-ray tube in the case of obtaining X-rays with high intensity has a common thing of structure which obtains the X-rays of high intensity by [as enlarging calorific capacity of the anode with which an electron beam is irradiated, and moving the portion which makes rotate the anode, and with which an electron beam is irradiated and heat distribution's becoming uniform] with the electron beam of a high current.
[0005]
[Problem(s) to be Solved by the Invention]At the above klystrons, since the interaction with the high frequency electric field at the time of an electron beam passing a cavity resonator was performed by the high frequency electric field of the resonator overflowing into the drift space through which an electron beam passes, there was a case where it became insufficient, by the center section of an electron beam.
[0006]The above X-ray tubes had the problem of consuming big electric power, in order to obtain the X-rays of high intensity.
[0007]An object of this invention is to cancel the above-mentioned problem and to provide an electron tube with sufficient energy efficiency.
[0008]

[Means for Solving the Problem]It is the negative pole in order to attain the above-mentioned purpose.
The anode which an electron taken out from this negative pole passes.
A collector electrode which catches an electron which passed this anode.
It is the electron tube provided with the above, and in said electron, comes to form said anode thinly so that a penetration is possible.
By this composition, an electron tube with sufficient energy utilization efficiency of an electron beam is obtained.
[0009]Potential of a collector electrode was made into a value lower than the anode. Thereby, since an electron beam is caught by voltage lower than voltage of the anode at a collector electrode, an electron tube with sufficient energy utilization efficiency of an electron beam is obtained.
[0010]Since energy of an electron beam consumed by the anode is reduced with constituting so that X-rays may occur by making said anode serve as a target and making said electron beam collide with this anode, a very good X-ray tube of energy utilization efficiency of an electron beam is obtained.
[0011]When kinetic energy of an electron which penetrated said anode considers thickness of said anode, and accelerating voltage of an electron impressed to this anode in such an X-ray tube as composition set as a value used as 10 or more keV, X-rays with a wavelength of 1 A or less can be generated, and sufficient substance penetrability power for X-rays can be given.
[0012]The anode of said X-ray tube is made into multilayer structure, and a surface at least is making at least one layer into other metal layers with a high mechanical strength whose density is lower than said metal layer at a metal layer which contributes to generating of X-rays, X ray generation efficiency, such as tungsten and copper, -- it is high (high-density) -- even if a mechanical strength uses a low substance for the anode and forms this thinly, a substance with a high mechanical strength with low density of other layers can be made to be able to support, and mechanical strength can be maintained.
[0013]A collector electrode of all the stages provide two or more steps of collector electrodes of said X-ray tube, carry out multiple connection of these electrically, and excluding a collector electrode of a final stage at least by what said electron forms thinly so that a penetration is possible. An electronic energy recovery is performed smoothly and efficiency can be improved rather than one step.
[0014]
[Embodiment of the Invention]Drawing 1 is a figure showing an embodiment of the invention, and shows the example of a klystron. In this figure, 1 is a metal membrane in which the negative pole, 2a, and 2b penetrate the electron in which an input and an output hollow resonator, and 3 constitute a collector electrode, 4 constitutes a heater, and 21, 22, 23, and 24 constitute the anode 2, respectively.
[0015]As shown in this figure, the input cavity resonator 2a and output hollow resonator 2b serve as the anode by same electric potential, and the seal of approval of the plate voltage Va is carried out between the negative poles 1. An electron is accelerated with this voltage and the metal membranes 21, 22, 23, and 24 formed by 5-micrometer-thick titanium are penetrated. The electron which penetrated the metal membrane is caught by the collector electrode 3 with the collector voltage Vc. In that case, if Vc is smaller than Va, the kinetic energy of the part electron can be collected and energy efficiency will become good.
[0016]As for the cavity resonator 2a and the metal membranes 21, 22, 23, and 24 of 2b, having been conventionally formed by a metallic mesh was common. Although the high frequency electric field was made from the resonator of a klystron in parallel with the direction which an electron beam penetrates, when it formed in a mesh, metal and space existed by turns, and since a high frequency electric field was jutted out of the metal part, it did not become parallel thoroughly with an electron beam. However, if this invention is used, it will be formed so that the high frequency electric field between the metal membranes which faced each other may become an electron beam and parallel

thoroughly. For this reason, the interaction of an electron beam and a high frequency electric field comes to be performed efficiently.

[0017]Drawing 2 is a figure showing other embodiments of this invention, in this figure, what is the same as for the thing of the same numerals as drawing 1, or corresponds is shown, and 2 is the anode in which the electron was thinly formed so that a penetration was possible. Drawing 3 is a figure showing the structure of the section of the anode used for drawing 2, 5 is a tungsten layer and 6 is a titanium layer.

[0018]An electron is taken out from the negative pole 1 and the anode 2 is irradiated with an electron by plate voltage Va=100kV. The anode 2 has the two-layer structure of the tungsten layer 5 and the titanium layer 6, as shown in drawing 3, and each thickness t1 and t2 to the direction of movement of an electron beam is t1=5micrometer and t2=10micrometer, for example. An electron collides with the tungsten which constitutes the anode, is slowed down, and emits X-rays. Since the anode is very as thin as tungsten 5micrometer and titanium 10micrometer, an electron beam penetrates the anode 2 and results in a collector electrode.

[0019]When it enters into the solid of the density rho and thickness t with the impingement rate V0, the speed V of the electron at the time of escaping from a solid is given by $V^4=V0^4$-CTxrhoxt. CT is a constant and is CT=5.05x10 ^{33} ($m^6kg^{-1}s^{-4}$) here.

[0020]When the speed of the electron which penetrated the anode 2 in this embodiment is found from this expression of relations, it turns out that it becomes the speed equivalent to the energy of 11keV. Energies at this rate are collected by impressing voltage V_C=10kV to a collector electrode.

[0021]In the X-ray tube which makes a high-speed electron collide with the anode, and is made to generate X-rays, the generating efficiency of X-rays is usually about 1%, and even if the thickness of the anode is thick, the yield of X-rays does not change. Therefore, conventionally, although the same X dose is obtained, the energies of 10keV are collected for the place for which the energy of 100keV was required by a collector electrode, and the efficiency rise of about ten percent is achieved.

[0022]Although this embodiment showed the case where the number of collector electrodes was one, even if it uses a collector electrode as multistage, the operation can form a same and efficient X-ray tube. For example, as shown in drawing 4, a collector electrode is constituted in two steps, 3a and 3b, the collector voltages Vc1 and Vc2 are given to these, respectively, and multiple connection is electrically carried out to them. Under the present circumstances, like the anode which mentioned above the other collector electrodes 3a except for the collector electrode 3b of a final stage, the electron forms thinly so that a penetration is possible. Thus, it is possible for an electronic energy recovery to be smoothly performed by using a collector electrode as multistage, and to constitute an efficient bulb from one step.

[0023]The X-rays by the side of long wavelength, i.e., low energy, are emitted from the X-rays of the wavelength corresponding to the accelerating voltage of the anode in an X-ray tube. This is because X-rays are emitted by the electron to which the electron was slowed down and energy fell inside the anode by the anode. X-rays differ in the transmissivity of the substance with the wavelength, and transmissivity becomes it small extremely that wavelength is 1 A or more. In the wavelength of X-rays, at 1 A or more, i.e., energy, a loss is large and capability as an X-ray tube cannot demonstrate enough at about 10 or less keV. Therefore, it is effective for the efficiency increase of an X-ray tube by making the anode penetrate, before electronic kinetic energy is set to 10 or less keV, not generating X-rays below the energy, and collecting energies with collector voltage. As electronic kinetic energy is high, it is better, but plate voltage is not exceeded.

[0024]It is more advantageous to use high-density metal for the anode, in order to raise the efficiency of an X ray generation. However, the thickness which can penetrate an electron only with high-density metal becomes extremely thin, a mechanical strength falls, and it is inconvenient. Then, this fault is canceled by making it the structure which piled up the tungsten layer for generating X-rays, and the metal layer of the low density which maintains a mechanical strength.

[0025]Titanium, black lead, etc. are effective as metal of the low density which maintains tungsten,

copper, and a mechanical strength as metal for generating X-rays. Although this embodiment showed the case where the anode was being fixed, it is also possible to rotate the anode like the conventional X-ray tube, and to make heat distribution of the anode uniform.

[0026]

[Effect of the Invention]As explained above, if this invention is used for the electron tube which has the negative pole, the anode which an electron passes, and a collector electrode which catches the passed electron, energy efficiency can be made better than before.

[0027]Make the anode made thin to such an extent that an electron penetrates especially serve as a target, and X-rays are generated, By arranging the collector electrode which catches the transmitted electron and impressing the voltage which makes small kinetic energy of a soft landing, i.e., an electron, at a collector electrode, and catches an electron to a collector electrode, Since the kinetic energy of the electron which penetrated the anode which did not contribute to generating of X-rays is recoverable, the X-ray tube with which the energy efficiency of an X ray generation has been improved can be provided.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is a figure showing an embodiment of the invention.
[Drawing 2]It is a figure showing other embodiments of this invention.
[Drawing 3]It is the figure to which the anode of drawing 2 was expanded.
[Drawing 4]It is a figure showing the embodiment of further others of this invention.
[Description of Notations]
1: The negative pole, 2:anode, a 2a:input cavity resonator, 2b:output hollow resonator, 3 and 3a, a 3b:collector electrode, 4:heater, 5:tungsten layer, 6:titanium layer, 21, 22, 23, 24 : metal membrane

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2.**** shows the word which can not be translated.
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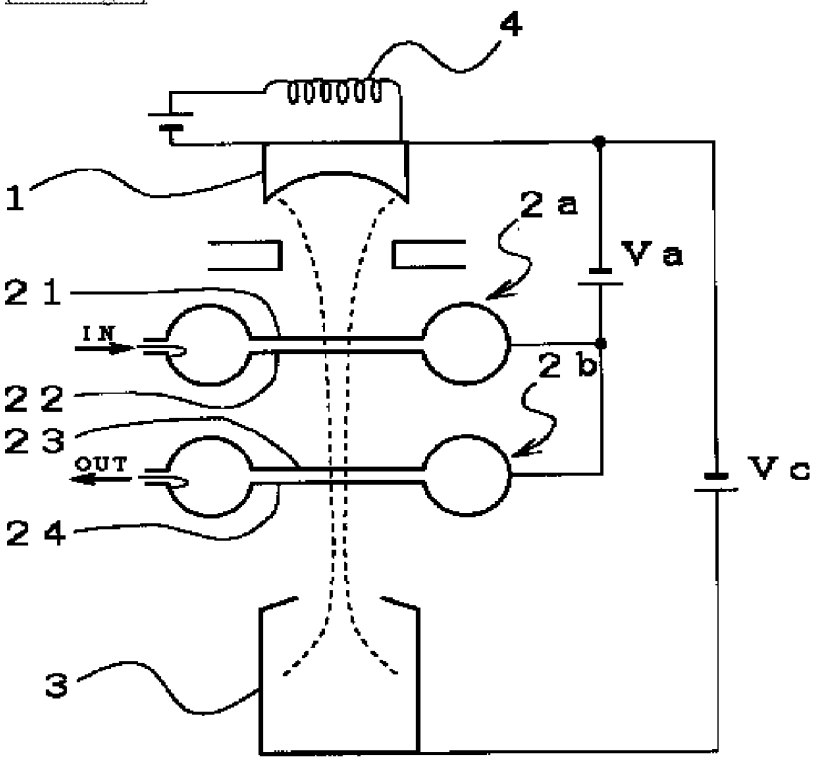
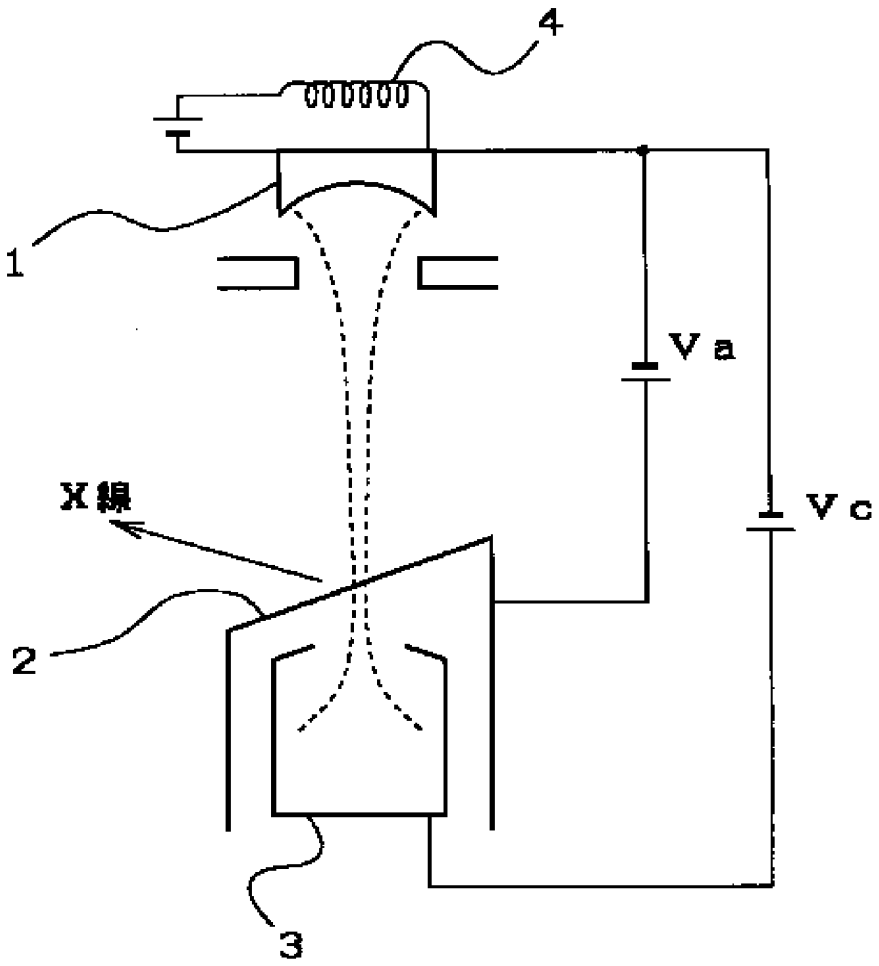
DRAWINGS

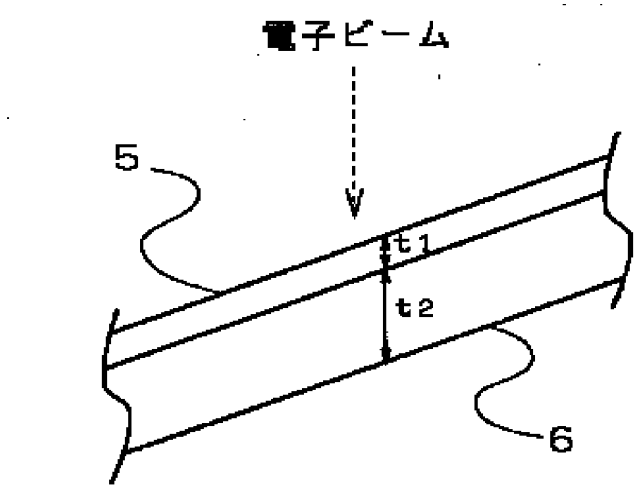
[Drawing 1]



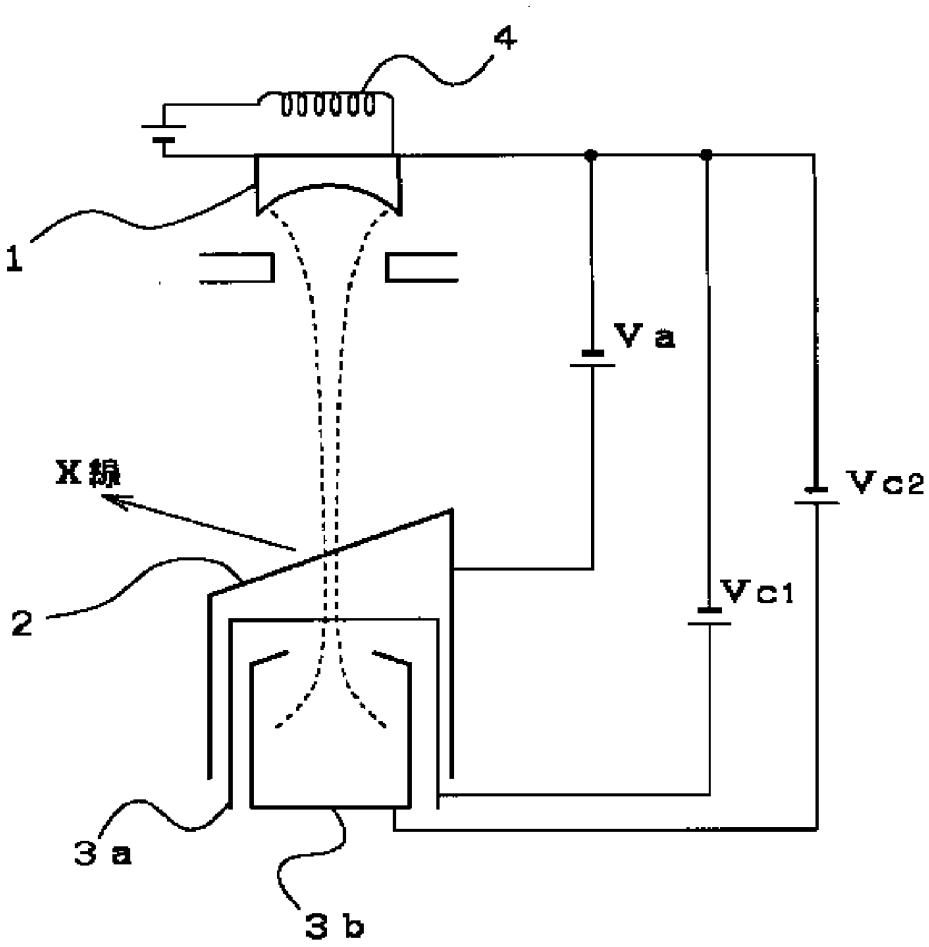
[Drawing 2]



[Drawing 3]



[Drawing 4]



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